THE PROCEEDINGS OF THE PHYSICAL SOCIETY

FROM JANUARY 1937 TO NOVEMBER 1937

VOLUME 49

Published by
THE PHYSICAL SOCIETY
1 Lowther Gardens, Exhibition Road
London, S.W. 7

Printed at
THE UNIVERSITY PRESS, CAMBRIDGE

12305

PRINTED IN GREAT BRITAIN

CONTENTS

Extra part. 31 *August* 1937

Report of a conference on the conduction of electricity in solids

PAGE

N. F. MOTT. Introduction v

R. W. POHL. Electron conductivity and photochemical processes in alkali-halide crystals 3

R. W. GURNEY and N. F. MOTT. Trapped electrons in polar crystals . . . 32

Discussion 36

R. HILSCH. Alkali-halide phosphors containing heavy metals 40

J. T. RANDALL. The effects of temperature on the intensity of fluorescence of some impurity solids 46

Discussion 57

J. H. DE BOER and E. J. W. VERWEY. Semi-conductors with partially and with completely filled 3*d*-lattice bands 59

Discussion 72

G. BORELIUS. Resistance of alloys with disordered and ordered arrangement of atoms 77

W. L. BRAGG, C. SYKES and A. J. BRADLEY. A study of the order-disorder transformation 96

C. H. DESCH. Age-hardening alloys 103

Discussion 108

G. I. FINCH. The structure of thin metallic films 113

E. T. S. APPLEYARD. Some factors influencing the resistance of thin metal films 118

A. FÉRY. A study of the electrical properties of thin films of platinum obtained by cathode sputtering in air and other gases (He, N_2, O_2 and H_2) . . . 136

J. BERNAMONT. Fluctuations in the resistance of thin films 138

J. E. LENNARD-JONES. The migration and aggregation of metal atoms on solid surfaces 140

Discussion 151

Part 1. 1 *January* 1937

J. S. ROGERS. Further experiments on the photographic action of gamma rays and on their absorption coefficients 1

N. R. CAMPBELL and R. S. RIVLIN. The effect of hydrogen on the time-lag of argon-filled photoelectric cells 12

WILLIAM BAND. Thermomagnetic properties of nickel wire. Part 3 14

E. A. OWEN and E. L. YATES. X-ray investigation of pure iron-nickel alloys. Part 1: Thermal expansion of alloys rich in nickel 17

J. G. G. CONYBEARE. The resistance of palladium and palladium-gold alloys . 29

R. COCKBURN. A determination of the fundamental types of electron oscillations in a triode valve 38

PAGE

J. C. M. Brentano. An X-ray goniometer using beams of large aperture for photographically recording crystal-powder reflections 61

Reviews of books 78

Part 2. 1 *March* 1937

J. H. E. Griffiths. A circuit for counting impulses at high speeds of counting . 85

A. C. B. Lovell. The electrical conductivity of thin films of the alkali metals spontaneously deposited on glass surfaces 89

R. C. Parker. The smoke method of measuring supersonic velocities . . 95

A. K. Taylor. Photometric test plates 105

John S. Anderson. The measurement of distortion in a gauge protection lens . 112

V. E. Cosslett. The structure and electrical conductivity of thin films of indium 121

H. L. Cox and D. G. Sopwith. The effect of orientation on stresses in single crystals and of random orientation on strength of polycrystalline aggregates . 134

E. N. da C. Andrade and R. Roscoe. Glide in metal single crystals . . . 152

E. A. Owen and E. L. Yates. X-ray investigation of pure iron-nickel alloys. Part 2. Thermal expansion of some further alloys 178

J. S. Preston and F. W. Cuckow. A photoelectric spectrophotometer of high accuracy 189

C. S. Hallpike, H. Hartridge and A. F. Rawdon-Smith. The response of the mammalian cochlea to phase-reversal in a continuous musical tone . . 190

Demonstration of the portable photoelectric daylight-factor meter . . . 194

Demonstration of the audible effect of a sudden change of phase in the current supplied to a telephone receiver 194

Reviews of books 198

Part 3. 1 *May* 1937

W. N. Bond. The viscosity of air 205

R. Naismith. Ionospheric conditions during the solar eclipse of 19 June 1936 . 214

H. Buckley. Note on the radiation between two coaxial radiating cylinders . 225

L. F. Bates and L. C. Tai. The magnetic properties of manganese amalgams . 230

Wilfred W. Barkas. Wood-water relationships, Part 3: Molecular sorption of water by Sitka spruce wood 237

H. Jones. The phase boundaries in binary alloys, Part 1: The equilibrium between liquid and solid phases 243

H. Jones. The phase boundaries in binary alloys, Part 2: The theory of the α, β phase boundaries 250

N. F. Mott. The energy of the superlattice in β brass 258

D. M. Myers. The division of primary electron current between grid and anode of a triode 264

A. G. Quarrell. Structural changes during the growth of metal films . . . 279

Ralph H. V. M. Dawton. Intensities of X-ray reflections from single crystals of sodium between 120 and 370° K. 294

PAGE

E. A. Owen and E. L. Yates. An X-ray investigation of pure iron-nickel alloys. Part 3: The thermal expansion of alloys rich in iron 307

E. A. Owen, E. L. Yates and A. H. Sully. An X-ray investigation of pure iron-nickel alloys. Part 4: The variation of lattice-parameter with composition . 315

E. A. Owen, E. L. Yates and A. H. Sully. An X-ray investigation of pure iron-nickel alloys. Part 5: The variation of thermal expansion with composition . 323

Reviews of books 326

Part 4. 1 July 1937

W. D. Wright and F. H. G. Pitt. The saturation-discrimination of two trichromats 329

J. H. Nelson. The colour-vision characteristics of a trichromat, Part 2 . . 332

C. W. Wilson. The effect of secondary beta radiation on gamma-ray measurements made in air 338

H. Lowery, H. Wilkinson and D. L. Smare. On the optical constants of alloys of the copper-zinc system 345

N. F. Mott. The theoretical interpretation of the optical constants of copper-zinc alloys 354

Wm. H. George. Sensitivity variation of X-ray photographic films 357

Harald Norinder. Rapid variations in the magnetic field produced by lightning discharges 364

R. Kingslake. The knife-edge test for spherical aberration 376

E. N. da C. Andrade and L. C. Tsien. The velocity-distribution in a liquid-into-liquid jet 381

L. R. G. Treloar. Secondary-electron emission from complex surfaces . . 392

M. C. Johnson and F. A. Vick. Thermionic approximations to the gas-covered fraction of an adsorbing surface, applied to the temperature dependence of oxygenation and oxidation of a tungsten filament 409

R. W. Powell. The thermal and electrical conductivity of a sample of Acheson graphite from 0° C. to 800° C. 419

Demonstration of a microscope for use with ultraviolet light, employing a reflecting optical system of aplanatic properties 427

Reviews of books 429

Part 5. 1 September 1937

W. H. S. Chance. The optical glassworks at Benediktbeuern 433

Allan H. Briggs. The estimation of ametropia by the coincidence optometer . 444

E. F. Fincham. The coincidence optometer 456

R. E. Reason. The development of the Fincham coincidence optometer . . 469

E. G. Richardson. An experimental study of turbulence diffusion 479

G. Burniston Brown. The vortex motion causing edge tones 493

G. Burniston Brown. The mechanism of edge-tone production 508

Mary D. Waller. The production of Chladni figures by means of solid carbon dioxide: Part 1, bars and other metal bodies 522

PAGE

W. Jevons, L. A. Bashford and H. V. A. Briscoe. Ultraviolet band-systems of GeCl and GeBr 532

W. Jevons, L. A. Bashford and H. V. A. Briscoe. The ultraviolet band-system of germanium monoxide 543

W. Jevons and L. A. Bashford. Ultra-violet band systems of SnBr and SiBr . 554

Y. P. Parti and R. Samuel. Absorption spectra of some carbon and tin halides in the vapour state 568

E. A. Owen and John Idwal Jones. The effect of pressure and temperature on the occlusion of hydrogen by palladium 587

E. A. Owen and John Idwal Jones. The palladium-hydrogen system . . 603

L. F. Bates and P. F. Illsley. The magnetic properties of iron amalgams . 611

F. E. Hoare and G. W. Brindley. The diamagnetic susceptibilities of dissolved and hydrated salts 619

Reviews of books 629

Part 6. 1 *November* 1937

L. F. Bates and P. G. Day. The electrical resistance of manganese amalgams . 635

L. F. Bates and A. W. Ireland. The magnetic properties of silver amalgams . 642

Walter G. Cady. The longitudinal piezoelectric effect in Rochelle-salt crystals . 646

H. C. Webster. An aperiodic amplifier for investigating the wave-form of atmospherics 654

H. C. Webster. Applications of the modulating electrode of television cathode-ray tubes in investigations of the wave-form of atmospherics 658

H. Dennis Taylor. On the use of rotating parallel-plane glass blocks for cinematography and for projection with continuously moving films . . . 663

H. H. Potter. The electrical resistance of ferromagnetics 671

S. L. Hussain and R. Samuel. Absorption spectra and photodissociation of halides and oxyhalides of sulphur, selenium and tellurium 679

Presentation of the fourteenth Duddell Medal to Professor Walter G. Cady, 9 July 1937 693

Obituary Notices 694

Reviews of books 711

Index to volume 49 718

PROCEEDINGS AT THE MEETINGS OF THE PHYSICAL SOCIETY

SESSION 1936–37

Except where the contrary is stated the meetings were held at the Imperial College of Science and Technology, South Kensington, the President being in the Chair.

9 *October* 1936

John Silvey Preston and John Martin Sleeman Speirs were elected Fellows of the Society.

The President announced that the Council had elected Richard Arthur Buckingham to Student Membership.

The following papers were read:

"The constancy of the velocity of sound at sonic frequencies", by F. A. WALCH, Ph.D.

"Vibration of a building partition at audio frequencies", by J. E. R. CONSTABLE, M.A., Ph.D., B.Sc., F.Inst.P.

"Vibration pattern of a wall transmitting sound", by J. E. R. CONSTABLE, M.A., Ph.D., B.Sc., F.Inst.P. and G. H. ASTON, M.A., Ph.D., B.Sc.

The following papers were read in title:

"Secondary emission from copper due to slow positive ions of argon", by F. LLEWELLYN JONES, M.A., D.Phil. and W. H. WILLOTT, Ph.D., B.Sc., A.Inst.P.

"X-ray investigation of pure iron-nickel alloys, Part I. Thermal expansion of alloys rich in nickel", by E. A. OWEN, M.A., Sc.D., D.Sc., F.Inst.P. and E. L. YATES, M.Sc., Ph.D.

Dr P. B. MOON showed some experiments in illustration of his paper on "The passage of neutrons through paraffin wax".

---

23 *October* 1936

The following were elected Fellows of the Society: Julius Hartmann, Stanley Hill, Otto Paul Theodor Kantorowicz, John Walter Kolbert, Harald Ernst Norinder, John Keith Roberts, Francis Arthur Vick.

The President announced that the Council had elected W. E. Trevelyan to Student Membership.

The following papers were read:

"A photoelectric spectrophotometer of high accuracy", by J. S. PRESTON, M.A., A.M.I.E.E., F.Inst.P. and F. W. CUCKOW, B.Sc.

"The resistance of palladium and palladium-gold alloys", by J. C. C. CONYBEARE.

The following papers were read in title:

"The ignition of explosive gases", by G. MOLE.

"Wireless waves reflected from the ionosphere at oblique incidence", by F. T. FARMER, B.Sc. and J. A. RATCLIFFE, M.A.

"A self-synchronizing time base for the distant observation of wireless pulse transmissions", by S. H. W. H. FALLOON, B.A. and F. T. FARMER, B.Sc.

"The electrical conductivity of barium chloride and its variation with temperature", by V. J. JEHU, B.Sc.

Prof. F. L. HOPWOOD, D.Sc., F.Inst.P., gave a demonstration of some experiments with singing tubes and coupled acoustic systems.

---

13 *November* 1936

Nevill Francis Mott and Kenneth John Proud were elected Fellows of the Society.

The President announced that the Council had elected John Anthony Chaldecott to Student Membership.

The following papers were read:

"The determination of the possible wave-lengths of electron oscillations in a triode valve", by R. COCKBURN, M.Sc., A.Inst.P.

"The viscosity of air", by W. N. BOND, M.A., D.Sc., F.Inst.P.

The following paper was read in title:

"Further experiments on the photographic action of γ rays and on their absorption coefficients", by J. S. ROGERS, B.A., M.Sc., F.Inst.P.

The following demonstrations were given by members of the staff of the Research Laboratories of the General Electric Company, Ltd.:

(i) A demonstration of phosphorescence.

(ii) A demonstration of a property of a hot spiral wire.

(iii) An experiment demonstrating the high electrical resistance of certain glasses.

---

27 *November* 1936

The following were elected Fellows of the Society: Emil Samuel Conradi, Robert Crispin Evans, R. Satyanarayan, William Hodge Taylor.

The President announced that the Council had elected Gordon Edward Erskine to Student Membership.

The following papers were read:

"The effect of hydrogen on the time lag of argon-filled photoelectric cells", by N. R. CAMPBELL, Sc.D., F.Inst.P. and R. S. RIVLIN.

"The smoke method of measuring supersonic velocities", by R. C. PARKER, B.Sc., Ph.D.

"An X-ray goniometer for photographically recording crystal-powder reflections by means of beams of large aperture", by J. C. M. BRENTANO, D.Sc., F.Inst.P.

"Thermomagnetic properties of nickel wire, Part III", by WILLIAM BAND, M.Sc.

A demonstration entitled "The response of the ear to the phase reversal of a continuous musical tone" was given by Professor H. HARTRIDGE, Dr C. S. HALLPIKE and Mr A. F. RAWDON-SMITH.

---

3 *December* 1936

The Meeting was held in the rooms of the Royal Society, Burlington House, London, W. 1, by kind permission of the President and Council.

Mr W. H. S. CHANCE delivered an address on "The optical glass works at Benediktbeuern".

The following papers were read:

"The measurement of distortion in a gauge projection lens", by J. S. ANDERSON, M.A., D.Sc., F.Inst.P.

"Photometric test plates", by A. K. TAYLOR, A.C.G.I., M.I.E.E.

---

11 *December* 1936

Cyril Dean Butler was elected a Fellow of the Society.

The following papers were read:

"A circuit for counting impulses at high counting speeds", by J. H. E. GRIFFITHS.

"The structure and electrical conductivity of thin films of indium", by V. E. COSSLETT, B.Sc., Ph.D.

The following papers were read in title:

"The effect of orientation on the stresses developed on the slip planes of single crystal specimens. With a note on the effect of random orientation on the strength of polycrystalline specimens", by H. L. COX, B.A. and D. G. SOPWITH, B.Sc.Tech., A.M.I.Mech.E.

"X-ray investigation of pure iron-nickel alloys, Part II. Thermal expansion of alloys containing between 41 and 24 per cent nickel", by E. A. OWEN, M.A., Sc.D., D.Sc., F.Inst.P. and E. L. YATES, M.Sc., Ph.D., A.Inst.P.

A demonstration entitled "The photoelectric daylight factor meter" was given by Mr G. P. BARNARD, A.Inst.P.

5, 6, 7 *January* 1937

The Twenty-seventh Annual Exhibition of Scientific Instruments and Apparatus was held at the Imperial College of Science and Technology.

The following discourses were delivered:

"Electrical measurements in the 'eighties, particularly those associated with Ayrton and Perry", by Sir JAMES SWINBURNE, M.I.E.E., F.R.S., on January 5th.

"The influence of industrial research on the development of scientific instruments", by HARRY MOORE, D.Sc., A.R.C.S., F.Inst.P., on January 6th.

---

22 *January* 1937

Cecil Baker and Norman Wright Robinson were elected Fellows of the Society.

The President announced that the Council had elected the following to Student Membership: Ethel Eva Widdowson, Arthur Charlesby, Ewart Harold Parfrey.

The prizes and certificates awarded for the eighth competition in craftsmanship and draughtsmanship were presented.

The following paper was read:

"Glide in metal single crystals", by E. N. da C. ANDRADE, F.R.S. and R. ROSCOE, Ph.D.

The following paper was read in title:

"The electrical conductivity of thin films of the alkali metals spontaneously deposited on glass surfaces", by A. C. B. LOVELL.

A demonstration of an experiment illustrating the Kutta-Joukowski effect was given by Professor E. N. da C. ANDRADE, F.R.S.

---

12 *February* 1937

The following were elected Fellows of the Society: Hugh Colin Webster, Donald Arthur Wright, Grenville Dennis Yarnold.

The President announced that the Council had elected Frank Scowen to Student Membership.

The following paper was read:

"Ionospheric conditions during the solar eclipse of June 19th, 1936", by R. NAISMITH, A.M.I.E.E.

The following papers were read in title:

"The radiation between two coaxial radiating cylinders", by H. BUCKLEY, M.Sc., F.Inst.P.

"The magnetic properties of manganese amalgams", by L. C. BATES, D.Sc., Ph.D., F.Inst.P. and L. C. TAI, B.Sc.

"X-ray investigation of pure iron-nickel alloys. Part III: Thermal expansion of alloys rich in iron. Part IV: Variation of lattice parameter and thermal expansion

coefficient with composition", by E. A. OWEN, M.A., Sc.D., D.Sc., F.Inst.P., E. L. YATES, M.Sc., Ph.D., A.Inst.P. and A. H. SULLY, M.Sc.

A demonstration of a ripple tank was given by Mr J. W. COTTINGHAM.

---

26 *February* 1937

The following were elected Fellows of the Society: A. A. Dee, Percy K. Boulnois, Ronald W. Douglas (transfer from Student Membership), Alexander Jenkins (transfer from Student Membership).

The following papers were read:

"Intensities of X-ray reflections from single crystals of sodium between 120 and 370° K.", by RALPH H. V. M. DAWTON.

"Structural changes during the growth of metal films", by A. G. QUARRELL, B.Sc., Ph.D., A.R.C.S.

The following papers were read in title:

"Wood water relationships, III. Further study of molecular sorption of water by Sitka spruce wood", by W. W. BARKAS, M.Sc.

"The division of primary electron current between grid and anode of a triode", by D. M. MYERS.

A demonstration of directly moulded optical systems and lenses was given by members of the staff of Combined Optical Industries, Ltd. (By arrangement with Major F. A. Freeth, O.B.E., F.R.S.)

---

12 *March* 1937

Annual General Meeting

The Minutes of the previous Annual General Meeting were read and accepted as correct.

The Reports of the Council and Hon. Treasurer were adopted.

The Officers and the Council for 1937–8 and the Auditors were elected.

Votes of thanks were accorded to the retiring Officers and Council and to the Governors of the Imperial College of Science and Technology.

Ordinary Meeting

The following were elected Fellows of the Society: William Henry Rann, Harry Wilman, K. Mendelssohn, L. J. Comrie, William Cochrane.

The following papers were read:

"The effect of secondary beta radiation on gamma-ray measurements made in air", by C. W. WILSON, M.Sc.

"The energy of the superlattice in β brass", by N. F. MOTT, M.A., F.R.S.

"A discussion of the factors which determine the phase boundaries in binary alloys. Part I: The equilibrium between liquid and solid phases. Part II: The theory of the α, β phase boundaries", by H. JONES.

A demonstration of a transmission photoelectric densitometer with semi-automatic plotting mechanism and improved voltage stabiliser was given by L. V. CHILTON and R. J. HERCOCK. (By arrangement with Mr Olaf Bloch.)

---

9 *April* 1937

The following were elected Fellows of the Society: James Howard Eagle Griffiths, Douglas Roaf.

The following papers were read:

"On the optical constants of alloys of the copper-zinc system", by H. LOWERY, D.Sc., Ph.D., F.Inst.P., H. WILKINSON, M.Sc.Tech. and D. L. SMARE, M.Sc.Tech.

"The theoretical interpretation of the optical constants of copper-zinc alloys", by N. F. MOTT, M.A., F.R.S.

The following papers were read in title:

"Sensitivity variation of X-ray photographic films", by W. H. GEORGE, M.Sc., Ph.D., F.Inst.P.

"Rapid variations in the magnetic field produced by lightning discharges", by HARALD NORINDER, Ph.D.

A demonstration of a special form of double pendulum was given by Dr R. S. CLAY.

---

23 *April* 1937

The following were elected Fellows of the Society: Alan Ewart Walter Austen (transfer from Student Membership), Frederick David Edwards, Albert John Philpot.

A demonstration of band systems of diatomic oxides in the uncondensed discharge in air was given by W. JEVONS, D.Sc., Ph.D.

The following papers were read:

"Thermionic approximations to the gas-covered fraction of an adsorbing surface, applied to the temperature-dependence of oxygenation and oxidation of a tungsten filament", by M. C. JOHNSON, M.A., D.Sc., A.Inst.P. and F. A. VICK, B.Sc., Ph.D., A.Inst.P.

"The thermal and electrical conductivities of a sample of Acheson graphite from 0° C. to 800° C.", by R. W. POWELL, B.Sc.

---

7 *May* 1937

A demonstration of Professor Carl Seashore's tests on certain psycho-physical functions, viz. discrimination of pitch, rhythm, intensity, time and consonance, was given by H. LOWERY, D.Sc., Ph.D., F.Inst.P.

A demonstration of a new irradiation monochromator was given by J. W. PERRY. (By the courtesy of Messrs Adam Hilger, Ltd.)

The following papers were read:

"The velocity distribution in a liquid-into-liquid jet", by E. N. DA C. ANDRADE, F.R.S. and L. C. TSIEN, B.Sc.

"Secondary-electron emission from complex surfaces", by L. R. G. TRELOAR, B.Sc.

---

28 *May* 1937

Douglas Stuart Spens Steuart was elected a Fellow of the Society.

The President announced that the Council had elected John Gilbert Daunt to Student Membership.

Mr B. K. JOHNSON gave a demonstration of a microscope, employing a reflecting optical system of aplanatic properties, for use with infra-red visible or ultra-violet radiation.

The following papers were read:

"The colour-vision characteristics of a trichromat, Part II", by J. H. NELSON, A.R.C.S., B.Sc.

"The saturation-discrimination of two trichromats", by W. D. WRIGHT, D.Sc., A.R.C.S. and F. H. G. PITT, Ph.D., A.R.C.S.

"The knife-edge test for spherical aberration", by R. KINGSLAKE, M.Sc., A.R.C.S.

---

3 *June* 1937

The Meeting was held in the rooms of the Royal Society, Burlington House, London, W. 1, by kind permission of the President and Council.

The following papers were read:

"The coincidence optometer", by E. F. FINCHAM, F.Inst.P.

"The development of the Fincham coincidence optometer", by R. E. REASON, A.R.C.S.

"The estimation of ametropia by the coincidence optometer", by ALLAN H. BRIGGS, M.Sc., M.B., Ch.B., D.O.M.S.

---

11 *June* 1937

George Allan Whipple was elected a Fellow of the Society.

A lecture demonstration dealing with calculating machines and their use in physical problems was given by Dr L. J. COMRIE.

The following paper was read:

"The production of Chladni figures by means of solid carbon dioxide: I. Bars and other metal bodies", by Miss MARY D. WALLER, B.Sc., F.Inst.P.

The following papers were read in title:

"The effect of pressure and temperature on the occlusion of hydrogen by palladium", by E. A. OWEN, M.A., D.Sc., F.Inst.P. and J. I. JONES, Ph.D.

"Ultra-violet band-systems of GeCl and GeBr", by W. JEVONS, L. A. BASHFORD and H. V. A. BRISCOE.

"The ultra-violet band system of germanium monoxide", by W. JEVONS, L. A. BASHFORD and H. V. A. BRISCOE.

---

25 *June* 1937

The following were elected Fellows of the Society: Philip M. Morse, Walter John Charles Chapple (transfer from Student Membership).

A demonstration of a model of a vibrating molecule was given by Dr W. H. J. CHILDS, of the Royal Institution.

The following paper was read:

"The vortex motion causing edge tones and the mechanism of its production", by G. B. BROWN, M.Sc., Ph.D.

The following papers were read in title:

"An experimental study of turbulence diffusion", by E. G. RICHARDSON, B.A., Ph.D., D.Sc.

"The diamagnetic susceptibilities of dissolved and hydrated salts", by F. E. HOARE, Ph.D. and G. W. BRINDLEY, Ph.D.

"The magnetic properties of iron amalgams", by L. F. BATES, D.Sc., Ph.D. and P. F. ILLSLEY.

---

26 *June* 1937

A visit was arranged to the Fuel Research Station at East Greenwich and the National Maritime Museum.

---

9 *July* 1937

The Fourteenth Duddell Medal was presented to Professor W. G. CADY, of the Wesleyan University, Middletown, Connecticut, U.S.A.

The following paper was read:

"The longitudinal effect in Rochelle salt crystals", by W. G. CADY.

The following papers were read in title:

"An aperiodic amplifier for investigating the wave form of atmospherics", by H. C. WEBSTER.

"Applications of the modulating electrode of television cathode ray tubes in investigations of the wave form of atmospherics", by H. C. WEBSTER.

A demonstration of piezo-electric apparatus was given by members of the staff of the National Physical Laboratory.

13, 14, 15, 16 *July* 1937

An informal conference on the conduction of electricity in solids was held at the H. H. Wills Physical Laboratory, University of Bristol, under the joint auspices of the Physical Society and the University of Bristol.

The following papers were read:

"Electron conductivity and photochemical processes in alkali-halide crystals", by R. W. POHL.

"Trapped electrons in polar crystals", by R. W. GURNEY and N. F. MOTT.

"Alkali-halide phosphors containing heavy metals", by R. HILSCH.

"The effects of temperature on the intensity of fluorescence of some impurity solids", by J. T. RANDALL.

"Semi-conductors with partially and with completely filled 3*d*-lattice bands", by J. H. DE BOER and E. J. W. VERWEY.

"Resistance of alloys with disordered and ordered arrangement of atoms", by G. BORELIUS.

"A study of the order-disorder transformation", by W. L. BRAGG, C. SYKES and A. J. BRADLEY.

"Age-hardening alloys", by C. H. DESCH.

"The structure of thin metallic films", by G. I. FINCH.

"Some factors influencing the resistance of thin metal films", by E. T. S. APPLEYARD.

"A study of the electrical properties of thin films of platinum obtained by cathode spluttering in air and other gases (He, N_2, O_2 and H_2)", by A FERY.

"Fluctuations in the resistance of thin films", by J BERNAMONT.

"The migration and aggregation of metal atoms on solid surfaces", by J. E. LENNARD-JONES.

REPORT OF COUNCIL FOR THE YEAR ENDING FEBRUARY 28, 1937

MEETINGS

DURING the period under review 14 Ordinary Science Meetings were held at the Imperial College of Science and Technology. At these meetings 56 papers were presented, of which 33 were read in title. Fourteen demonstrations were given.

A Science Meeting was held on June 5, 1936, at Bedford College by the kind invitation of Professor W. Wilson, F.R.S. Before the meeting the Physics Department was open to members of the Society and their guests, who were also entertained to tea by Professor Wilson.

A Special Optical Meeting was held on the evening of December 3, 1936, in the rooms of the Royal Society, by kind permission of the President and Council. Mr W. H. S. Chance delivered an address on "The Optical Glass Works at Benediktbeuern", and two papers on optical subjects were also read and discussed.

SUMMER MEETING AT THE RESEARCH LABORATORIES OF THE GENERAL ELECTRIC COMPANY

A visit was paid on June 19, 1936, to the Research Laboratories of the General Electric Company, Ltd., Wembley, by the kind invitation of the Director, Mr C. C. Paterson. During the tour of the laboratories many interesting demonstrations were shown by members of the staff. About 220 members and friends were present.

THE GUTHRIE LECTURE

The Twenty-first Guthrie Lecture was delivered on May 15, 1936, by Professor F. A. Lindemann, F.R.S., who took as his subject "Physical Ultimates".

THE DUDDELL MEDAL

The Council has awarded the Fourteenth Duddell Medal to Professor W. G. Cady of the Wesleyan University, Middletown, Connecticut, U.S.A., for his work on quartz resonators.

ANNUAL EXHIBITION

The Twenty-seventh Annual Exhibition was held on January 5, 6 and 7, 1937, at the Imperial College of Science and Technology, by the courtesy of the Governing Body.

Seventy-eight firms exhibited their products in the Trade Section and four firms displayed technical literature. In addition to the Trade Section there were nineteen exhibits in the Research and Educational Section contributed by Research Associations, Government and Industrial Laboratories and private individuals. As in previous years, the exhibits entered for the Apprentices and Learners Competition held in conjunction with the Exhibition were on view. The attendance during the three days was over 7000.

The following discourses were given:

"Electrical Measurements in the 'Eighties, particularly those associated with Ayrton and Perry", by Sir James Swinburne, M.I.E.E., F.R.S.

"The Influence of Industrial Research on the Development of Scientific Instruments", by Harry Moore, D.Sc., A.R.C.S., F.Inst.P.

PROGRESS REPORTS

The sales of Volume II have been very satisfactory and the stock is now almost exhausted.

Volume III was published recently and will be found to be as comprehensive in scope as the two preceding volumes.

SPECIAL OPTICAL MEETINGS

A new series of meetings to be devoted to the discussion of optical subjects has been inaugurated. These meetings are additional to the ordinary science meetings held on Fridays, and take place as frequently as the offer of suitable papers, demonstrations, lectures or discussions permits. The time and place of meeting is chosen to suit the convenience of members engaged in the optical industry. The first meeting of this series was held on December 3, 1936, and details are given in another section of the report.

APPOINTMENT OF ASSISTANT SECRETARY

The Council has appointed Miss J. I. Dennis Assistant Secretary.

HERBERT SPENCER LEGACY

A legacy of £1241 was bequeathed to the Society during the year by the late Herbert Spencer. It has been decided that part of this legacy may be used for grants to Fellows of the Society who are undertaking research in some branch of physical science which involves the construction of special apparatus, the cost of which cannot be otherwise provided for. Another part of this legacy has been allocated to the Joint Library Committee for the purpose of repairing books of historic interest.

CONFERENCE AT BRISTOL

An Informal Conference on the Conduction of Electricity in Solids and allied subjects has been arranged under the joint auspices of the Physical Society and the University of Bristol at the H. H. Wills Physical Laboratory, University of Bristol, from Tuesday, July 13, to Friday, July 16, 1937.

REPRESENTATION ON OTHER BODIES

The Physical Society has been represented on other bodies as follows:

British National Committee for Physics: Mr T. Smith, Dr E. Griffiths, Mr J. H. Awbery, Professor A. M. Tyndall.

British National Committee for Scientific Radio: Professor E. V. Appleton, Dr A. B. Wood, Professor L. S. Palmer.

Committee of Management of Science Abstracts: Professor A. Ferguson, Dr D. Owen, Mr J. H. Awbery, Dr W. Jevons.

Board of the Institute of Physics: Dr D. Owen, Dr A. B. Wood.

Joint Committee on Symbols for Thermodynamics: Professor A. Ferguson, Mr J. H. Awbery, Professor A. C. Egerton, Professor G. I. Finch.

British Standards Institution Committee on Optical Projection Apparatus: Professor A. F. C. Pollard, Dr R. S. Clay.

British Standards Institution Committee on Radio Interference Suppression: Professor G. I. Finch.

Organizing Committee for a Discussion on Lubrication and Lubricants (Institution of Mechanical Engineers): Professor G. I. Finch.

OBITUARY

The Council records with deep regret the deaths of the following Fellows: Professor A. Anderson, Mr D. J. Blaikley, Sir Henry H. Cunynghame, Mr W. W. Drury, Professor G. Forbes, Mr C. E. Haselfoot, Mr C. E. Holland, Dr C. V. Jackson, Sir Herbert Jackson, Mr A. C. Jolley, Mr J. A. Morrow, Sir Joseph E. Petavel, Professor J. Rice, Mr J. Rose-Innes, Dr J. H. Vincent, Dr R. S. Willows.

MEMBERSHIP ROLL AT DECEMBER 31, 1936

	Total Dec. 31, 1935	Changes during 1936			Total Dec. 31, 1936
Honorary Fellows	11			–	11
Honorary Fellows (Optical Society)	7			–	7
Ex-officio Fellows	4			–	4
Ordinary Fellows	940	Elected	36		
		Student transfers ...	5		
			41		
		Deceased	14		
		Resigned or lapsed ...	22		
			36		
		Net change		5	945
Students	84	Elected	15		
		Transferred to Fellows	5		
		Resigned or lapsed ...	8		
			13		
		Net increase		2	86
Total Membership	1046	Net increase		7	1053

REPORT OF THE HONORARY TREASURER

The accounts reveal a satisfactory financial position. The anticipated saving in the cost of the "Proceedings" mentioned in last year's report has been realized.

The Society desires to thank the Council of the Royal Society for a grant of £100 towards the cost of publications.

The Society's investments have been valued at market prices on December 31st, 1936 through the courtesy of the Manager of the Charing Cross Branch of the Westminster Bank.

(Signed) ROBERT W. PAUL
Honorary Treasurer

February 18th, 1937

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1936

1935 £ s. d.	Expenditure	£ s. d.	£ s. d.
	To		
583 0 0	"Science Abstracts"		501 0 0
	Normal Publications:		
2299 17 0	"Proceedings" and Exhibition Catalogue	1790 2 6	
39 19 11	Notices	39 8 6	
204 5 11	Editorial and General Expenses	201 2 10	
			2030 13 10
	Special Publications:		
514 2 7	"Reports on Progress in Physics" (Vol. II)		714 15 1
634 11 5	"*Reports of International Conference*"		
350 15 2	Postage on Normal Publications and General Correspondence		310 9 5
32 19 0	Expenses at Meetings		34 16 8
8 18 11	Periodicals and Library		6 15 11
	Institute of Physics:		
528 16 0	Clerical Assistance and Office Expenses	625 3 0	
272 13 4	Electricity, Labour and Sundries in connexion with Exhibition	295 5 0	
			920 8 0
92 3 9	Sundry Expenses		97 6 5
40 0 0	Honoraria to Lecturers		20 0 0
49 7 1	*Printing and despatching List of Members*		
	Balance, being excess of Income over Expenditure, carried forward to Accumulated Fund		616 5 11
£5651 10 1			£5252 11 3

1935 £ s. d.	Income	£ s. d.	£ s. d.
	By		
	Subscriptions:		
56 14 0	Entrance Fees	35 14 0	
1654 18 10	Fellows*	1687 6 2	
4 4 0	Voluntary†	4 4 0	
39 13 6	Students	44 2 0	
109 0 9	For "Science Abstracts" and Advance Proofs	114 3 7	
			1885 9 9
30 0 0	Transfer from Life Composition Fund of amounts paid by Fellows now deceased		70 0 0
	Sales:		
955 11 2	Normal Publications	927 6 10	
569 11 11	International Conference Reports	112 1 9	
514 11 10	"Progress Reports" (Vol. II)	749 17 9	
			1789 6 4
396 2 3	Advertisements in Publications		409 9 8
	Dividends from Investments	270 9 2	
	Less Transfer to Duddell Memorial Fund	14 0 0	
258 11 2			256 9 2
	Royal Society Grant for Publications		100 0 0
774 2 7	Exhibitors' and other Payments on account of Exhibition		741 16 4
288 8 1	*Balance, being excess of Expenditure over Income, carried forward to Accumulated Fund*		
£5651 10 1			£5252 11 3

• Eighty-eight Fellows paid reduced subscriptions by the arrangement with the Institute of Physics, the total rebate being £34. 10s. 2d.

† Voluntary subscriptions are subscriptions paid by Fellows who compounded for the low sum of £10.

BALANCE SHEET AS ON 31ST DECEMBER, 1936

BALANCE SHEET AS ON 31st DECEMBER, 1936

LIABILITIES

	£ s. d.	£ s. d.	£ s. d.
Sundry Creditors		1264 14 3	
Life Compositions:			
As on December 31, 1935	1562 10 0		
Add Payment during year	31 10 0		
	1594 0 0		
Less Transfer to Income and Expenditure Account of amounts paid by Fellows now deceased	70 0 0	1524 0 0	
Subscriptions paid in advance:			
Members	61 3 9		
Publications	154 4 11		
		215 8 8	
			3004 2 11
SPECIAL FUNDS			
W. F. Stanley Trust Fund		397 0 0	
Duddell Memorial Trust Fund		430 0 9	
Optical Convention 1926, Trust Account		49 1 8	
Special Reports on Physics Account		83 1 0	
Herbert Spencer Legacy		1241 0 0	
			2200 3 5
GENERAL FUND			
Accumulated Fund:			
As on December 31, 1935		3546 0 9	
Add Increase in value of Investments		15 18 0	
Add Balance of Income and Expenditure Account		616 5 11	
		4178 4 8	
A. W. Scott Bequest		174 15 3	
			4352 19 11
			£9557 6 3

ASSETS

	£ s. d.	£ s. d.	£ s. d.
Investments at Market Value on December 31st, 1936:			
£2100 Consolidated Stock 2½%	1768 0 0		
£1000 War Loan 3½% Inscribed "A" Account	1052 0 0		
£750 War Loan 3½% Registered	788 0 0		
£650 Funding Loan 4%	752 0 0		
£500 India 3½% Stock	490 0 0		
£400 Lancaster Corporation 3%	388 0 0		
£399 London Midland and Scottish Railway 4% Debenture Stock	426 0 0		
£1000 London Midland and Scottish Railway 4% Preference Stock	905 0 0		
£500 London and North Eastern Railway 4% Debenture Stock	530 0 0		
£150 Southern Railway 5% Debenture Stock	201 0 0		
£300 Southern Railway Preferred Ordinary Stock	285 0 0		
£442 Southern Railway Deferred Ordinary Stock	112 0 0		
£400 War Loan 3½% Inscribed "B" Account	421 0 0		
		8118 0 0	
Dividends due from Investments		38 12 10	
Inland Revenue—Income Tax claimed for 1936		18 12 9	
Subscriptions due		16 5 6	
Sundry Debtors		158 14 1	
Cash at Bank: Current	694 19 10		
Cash on Deposit	500 0 0		
Cash in hand	12 1 3		
		1207 1 1	
			£9557 6 3

NOTE: These accounts do not include the usual liabilities incurred in 1936 in respect of publications to be issued in 1937, amounting to approximately £953.

Stock of publications on December 31st, 1936. At Honorary Treasurer's valuation . . . £1410. 3s. 0d.

ROBERT W. PAUL, *Honorary Treasurer.*

We have audited the above Balance Sheet and have obtained all the information and explanations we have required. We have verified the bank balances and the Investments. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Society's affairs according to the best of our information and the explanations given to us and as shown by the books of the Society.

SPENCER HOUSE, SOUTH PLACE, E.C. 2
February 18th, 1937.

KNOX, CROPPER & CO.,
Chartered Accountants.

LIFE COMPOSITION FUND ON DECEMBER 31ST, 1936

	£	s.	d.
45 Fellows paid £10	450	0	0
1 Fellow paid £15	15	0	0
16 Fellows paid £21	336	0	0
1 Fellow paid £30	30	0	0
22 Fellows paid £31. 10s.	693	0	0
	£1524	0	0

SPECIAL FUNDS

W. F. STANLEY TRUST FUND

	£	s.	d.		£	s.	d.
Carried to Balance Sheet	397	0	0	£300 Southern Railway Preferred Ordinary Stock	285	0	0
				£442 Southern Railway Deferred Ordinary Stock	112	0	0
	£397	0	0		£397	0	0

DUDDELL MEMORIAL TRUST FUND

CAPITAL

	£	s.	d.		£	s.	d.
Carried to Balance Sheet	421	0	0	£400 War Loan 3½% Inscribed "B" Account	421	0	0

REVENUE

	£	s.	d.		£	s.	d.
Engraving medals	12	12	0	Balance on December 31st, 1935	22	12	9
Honorarium to Medallist	15	0	0	Interest	14	0	0
Balance carried to Balance Sheet	9	0	9				
	£36	12	9		£36	12	9

OPTICAL CONVENTION, 1926, TRUST ACCOUNT

	£	s.	d.		£	s.	d.
Balance carried to Balance Sheet	49	1	8	Balance on December 31st, 1935	39	11	9
				Sales of Publications	9	9	11
	£49	1	8		£49	1	8

A. W. SCOTT BEQUEST

	£	s.	d.		£	s.	d.
Expenses in connexion with Library	11	4	3	Balance on December 31st, 1935	185	19	6
Balance carried to Balance Sheet	174	15	3				
	£185	19	6		£185	19	6

"SPECIAL REPORTS ON PHYSICS" ACCOUNT

	£	s.	d.		£	s.	d.
Balance carried to Balance Sheet	83	1	0	Balance on December 31st, 1935	83	1	0

HERBERT SPENCER LEGACY

	£	s.	d.		£	s.	d.
Balance carried to Balance Sheet	1241	0	0	Cash received during year	1241	0	0

OFFICERS AND COUNCIL, 1937–1938

President:

T. SMITH, M.A., F.INST.P., F.R.S.

Vice-Presidents:

Who have filled the Office of President.

SIR OLIVER J. LODGE, D.SC., LL.D., F.INST.P., F.R.S.
SIR J. J. THOMSON, O.M., SC.D., F.INST.P., F.R.S.
PROF. SIR CHARLES VERNON BOYS, LL.D., F.INST.P., F.R.S.
PROF. C. H. LEES, D.SC., F.INST.P., F.R.S.
PROF. SIR W. H. BRAGG, K.B.E., M.A., F.INST.P., F.R.S.
ALEXANDER RUSSELL, M.A., D.SC., F.INST.P., F.R.S.
SIR FRANK E. SMITH, K.C.B., C.B.E., D.SC., F.INST.P., SEC. R.S.
PROF. O. W. RICHARDSON, M.A., D.SC., F.R.S.
W. H. ECCLES, D.SC., F.INST.P., F.R.S.
PROF. SIR A. S. EDDINGTON, M.A., D.SC., F.R.S.
PROF. A. O. RANKINE, O.B.E., D.SC., F.INST.P., F.R.S.
THE RIGHT HON. LORD RAYLEIGH, M.A., SC.D., LL.D., F.INST.P., F.R.S.

Vice-Presidents:

R. S. WHIPPLE, M.I.E.E., F.INST.P.
EZER GRIFFITHS, D.SC., F.INST.P., F.R.S.
D. OWEN, B.A., D.SC., F.INST.P.
J. H. AWBERY, B.SC., F.INST.P.

Hon. Secretaries:

W. JEVONS, D.SC., PH.D., F.INST.P.
ALLAN FERGUSON, M.A., D.SC., F.INST.P.

Hon. Foreign Secretary:

PROF. O. W. RICHARDSON, M.A., D.SC., F.R.S.

Hon. Treasurer:

R. W. PAUL, M.I.E.E., F.INST.P.

Hon. Librarian:

J. H. BRINKWORTH, D.SC., A.R.C.S., F.INST.P.

Ordinary Members of Council:

PROF. W. WILSON, D.SC., PH.D., F.R.S.
T. Y. BAKER, B.A., F.INST.P.
PROF. C. D. ELLIS, B.A., PH.D., F.R.S.
PROF. G. I. FINCH, M.B.E., F.INST.P.
H. SHAW, D.SC., A.R.C.S., F.INST.P.
PROF. H. R. ROBINSON, D.SC., PH.D., F.INST.P., F.R.S.
H. T. FLINT, D.SC., PH.D.
L. F. BATES, D.SC., PH.D., F.INST.P.
L. HARTSHORN, D.SC., A.R.C.S.
PROF. F. L. HOPWOOD, D.SC., F.INST.P.
A. B. WOOD, D.SC., F.INST.P.
C. V. DRYSDALE, C.B., O.B.E., D.SC., M.I.E.E., F.INST.P.

Editor of the Proceedings:

CAPT. C. W. HUME, M.C., B.SC.

Assistant Secretary:

MISS J. I. DENNIS

REPORT

OF A

JOINT COMMITTEE

OF

THE CHEMICAL SOCIETY, THE FARADAY SOCIETY, AND THE PHYSICAL SOCIETY

ON

SYMBOLS

FOR

THERMODYNAMICAL AND PHYSICO-CHEMICAL QUANTITIES

AND

CONVENTIONS

RELATING TO THEIR USE

ADOPTED AS RECOMMENDED PRACTICE

in

The Proceedings of the Physical Society,
The Transactions of the Faraday Society,
The Journal of the Chemical Society,

and

British Chemical Abstracts

Members of any of the three Societies may obtain extra copies of this Report at 4*d*. per copy or 5*s*. per 25 copies, post free, on application to the Secretary of the appropriate Society.

Non-members may purchase copies of the Report at 6*d*. per copy or 7*s*. 6*d*. per 25 copies, post free, from the Assistant Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1.

PART I.

INTRODUCTION.

The objects of the Joint Committee have been :

(i) **To correlate the views of chemists and physicists with regard to the use of symbols for quantities employed in thermodynamics, and to eliminate as far as possible the confusion that has arisen through the considerable diversity of usage in this field** (see Part II below).

(ii) **To deal similarly with symbols for other quantities which are of interest to both chemists and physicists** (see Part III below).

The Joint Committee has examined the recommendations contained in the published reports of other bodies which have been concerned with symbols in recent years. In regard to symbols for thermodynamical quantities, particular attention was given to the "Report on Symbols, Units, and Nomenclature" of the International Conference on Physics (1934); and in regard to symbols for physico-chemical quantities, to the old "List of Physico-Chemical Symbols" which the Chemical Society had decided to revise, and to a provisional draft of "Standard Chemical Symbols and Abbreviations", drawn up recently by the British Standards Institution (largely on the basis of the old Chemical Society list).

Through the good offices of Mr. Sanford A. Moss, of the American Standards Association, an interim report of the Joint Committee was communicated informally to an "Informal International Conference on Letter Symbols for Heat and Thermodynamics" held in New York in September 1936; and the Joint Committee has had access to an advance copy of a preliminary report of this Conference. Consideration has also been given to a "Preliminary List of Abbreviations" recently circulated by the Royal Society.

The Joint Committee has given due consideration to usages adopted by authors of well-known text-books on relevant subjects; and to special lists of symbols in current use by workers in various fields, drawn up by individual members of the Committee.

In submitting this Report the Joint Committee wishes to draw attention to the fact that although recommendations regarding the use of physico-chemical symbols have been put forward in the past by a number of committees, these bodies have nearly always been representative of *either* physicists *or* chemists, and not as in the present instance of both.

In carrying out its work the Joint Committee has been guided y the following principles :

(i) Symbols and conventions regarding their use should be chosen from among those already widely adopted, unless there are definite objections to all current usages.

In choosing between possible alternative symbols and conventions preference should be given, in general, to the **practice and needs of chemists and physicists,** and to practice in English-speaking countries.

It is fully recognised that it would be highly advantageous to secure complete agreement with workers in fields other than chemistry and physics—especially with engineers in regard to thermodynamical symbols. It has to be realised, however, that this involves special difficulties, due not only to the strong feelings which workers in particular fields hold in favour of their accustomed symbols, but also to the *limited number of alphabets and founts* available for the representation of the large number of quantities to be referred to in the various branches of science and technology. Nevertheless, care has been taken to avoid as far as possible any direct conflict with established usage in related fields, and thus to leave open the way to a wider range of agreement in the future.

Where general agreement on preference for a particular symbol or convention is not reached, **alternatives** should be given; but one of such alternatives may be indicated as the **first preference.**

(ii) Symbols for quantities constituting a well-defined class should, if possible, belong to the same alphabet, fount, and case, which should be such as to permit of modification in accordance with a uniform scheme for the representation of any important series of corresponding derived quantities.

Methods of modifying symbols by means of **subscripts, superscripts, etc.** should be systematised as far as possible.

(iii) There should be no departure from the standard practice of mathematicians regarding the use of signs, operator symbols, etc.

It is recognised that the detailed recommendations contained in Parts II and III of the Report will not cover all the requirements of workers in any particular field, but it is hoped that they will afford a common basis for practice in a wide range of specialised branches of science.

An important advance towards uniformity of usage will have been achieved if the quantities which appear in the lists below are represented whenever possible by the symbol recommended, or, when this is not possible, by an alternative symbol chosen in accordance with the principles set forth above. It is realised that owing to the limited number of available alphabets many of the symbols appearing in the following lists will have to be used in certain branches of science for quantities which are not referred to in this Report. There can be no objection to this provided that there is no danger of confusion with the quantities which the symbol represents in the lists below.

PART II.

SYMBOLS FOR QUANTITIES EMPLOYED IN GENERAL THERMODYNAMICS, WITH CONVENTIONS RELATING TO THEIR USE.

(Where two or more symbols separated by commas are given for a quantity, these symbols are to be regarded as alternatives for which no preference is expressed. On the other hand, where two symbols are separated by a dotted line, the former is the first preference.)

1. Quantities of energy entering or leaving a system: general symbols:

Heat	q
*Work	w . . . W

For **heat** entering the system q is positive; for heat leaving the system it is negative. The symbol q should never be used with the opposite convention as to sign.

For **work** the question of sign is left open, for, although there is much support on historical grounds and from the standpoint of convenience in certain relations for treating work done *by* the system as positive, there is also support for the reverse convention which would result in all forms of energy entering the system being treated as positive.

Subscripts p, v, T, etc., may be added to either of the above symbols to indicate conditions of constant pressure, volume, temperature, etc. The subscript q may be added to w or W to indicate adiabatic conditions, and the subscript w to q to show that no work is done in a process.

2. General properties of the System itself.

Temperature, on absolute scale, (°K)	T
Pressure	p, P
Volume	v, V
General thermodynamic functions	
intrinsic energy	U . . . E
enthalpy, total heat, or heat content	$H\ (= U + pv)$ †
entropy	S
*free energy (Helmholtz)	A . . . F $(= U - TS)$
thermodynamic potential, Gibbs function, or free energy (Lewis and Randall)	$G\ (= H - TS)$

* In an endeavour to attain international uniformity, the suggestion that A should be used as the preferred symbol for Helmholtz free energy has been adopted. It is important, therefore, that this symbol shall *not* be used to denote the work done by or on a system.

† May also be defined in terms of generalised forces and co-ordinates as $U + \Sigma Xx$, where X corresponds to p and x to v.

Heat capacity per gram (specific heat)	
at constant volume	c_v
at constant pressure	c_p
per mol (molecular heat)	
at constant volume	C_v
at constant pressure	C_p
Ratio of specific heats	γ
Latent heat per gram	l
per mol	L
Heat of reaction	see note below
Vapour pressure constant	i
Chemical potential	μ
Activity	a

The above symbols represent the magnitudes of the properties specified and should not be used, either by themselves or with the addition of suffixes or bars, to denote changes in these magnitudes. An *increase* in a property X should be denoted by ΔX, and a *decrease* by $-\Delta X$, or, if the change is *very small*, by δX and $-\delta X$ respectively. The forms dX and ∂X should be used only for the respective *differential* and *partial differential*.

The value of a property X for a particular system or for a system in a particular state may be indicated by means of a numeral subscript, e.g. X_{I}, X_{II}, X_1, X_2, etc. An increase in the value of X when the system changes from state 1 to state 2, may be represented by $(\Delta X)_{1,2}$ or $(\Delta X)_{1\rightarrow 2}$ $(= X_2 - X_1)$.

Subscripts A, B, C, etc. may be used for reference to the molecular species A, B, C, etc.

Note on Heat of Reaction :

It is recommended that all thermochemical data be expressed by quoting the equation of the chemical reaction followed by the value of ΔH or ΔU : e.g. for the heat of reaction at a constant pressure of 1 atmosphere—

$CH_3OH(\mathrm{liq.}) + 1\frac{1}{2}O_2(\mathrm{gas}) = CO_2(\mathrm{gas}) + 2H_2O(\mathrm{liq.})$; $\Delta H_{298} = -173{,}630$ cal.

and for the heat of reaction at constant volume: $\Delta U_{298} = -173{,}330$ cal.

The use of a special symbol, such as Q, to denote the heat *evolved* in a chemical reaction—as was formerly customary in thermochemistry—is not recommended. The most important point is, however, that in using ΔU, ΔH, (or the general symbol q) to denote heat of reaction they must have a positive value for an endothermic reaction and a negative value for an exothermic reaction.

PART III.

SYMBOLS FOR PHYSICO-CHEMICAL QUANTITIES, WITH CONVENTIONS RELATING TO THEIR USE.

(including symbols for thermodynamic quantities given in Part II.)

A. GENERAL RECOMMENDATIONS REGARDING ALPHABETS AND FOUNTS.

In order to make the best use of the limited number of alphabets and founts commonly available and thus minimise the number of uses to which each letter in a given fount and case is put, the following recommendations are made:

(a) **Symbols for quantities** (except purely mathematical constants—see (b) below) should be printed in *italic* (*not* roman) type when they are not greek. See list below, B (2).

It is recommended that **symbols for certain important physical constants in common use**—see list below, B (1)—should be printed in ***black italic*** type. This will relieve the pressure on certain overworked letters and have the advantage that symbols for these quantities having known constant values will stand out against symbols for variables in equations. It is understood that all reputable printers can supply black italic in addition to Clarendon and other black types, so that there should be no risk of confusion with the broad-faced black roman type commonly employed for representing vector quantities. In writing, as distinct from printing, it is suggested that where possible the symbols for these physical constants be represented by cursive letters, e.g. $\mathcal{F}$ as distinct from F, or, especially in blackboard writing, by means of a different colour. In typescript these symbols may be underlined in red, to distinguish them from those to be printed in ordinary italic (underlined in black).

(b) **Symbols for purely mathematical constants and symbols denoting mathematical operations**—see list below, B (3a)—should be printed in roman (*not* italic) type when they are not greek.

(c) **Symbols for the chemical elements** should always be printed in roman type.

(d) **Abbreviations for words**—as distinct from symbols for quantities—should be printed in roman type and followed by a full stop. Examples of single-letter abbreviations are given below, B (3b).

Single capital letters used as abbreviations should be printed in SMALL ROMAN TYPE so that they stand out in the text and are readily distinguished from symbols for the chemical elements.

B. LISTS OF RECOMMENDED SYMBOLS AND CONVENTIONS,

including single-letter abbreviations.

(Where two or more symbols separated by commas or semicolons are given for a quantity, these symbols are to be regarded as alternatives for which no preference is expressed. On the other hand, where two symbols are separated by a dotted line, the former is the first preference.)

1. To be Printed in Black Italic.

(Certain important physical constants.)

F Faraday's constant.
J Mechanical equivalent of heat.
N Avogadro's number.
R {Gas constant per mol. / Rydberg's constant.}
c Velocity of light in vacuo.
e Electronic charge (charge equal and opposite in sign to that of an electron).
g Acceleration due to gravity (standard value, if variation from standard is significant).
h Planck's constant.
k Boltzmann's constant.
m Rest mass of an electron.

2. To be Printed in Ordinary Italic, when not Greek.

General Physics and Chemistry.

Length	l
mean free path of molecules	l
height	h
diameter, distance	d
diameter of molecules	σ
radius	r
Mass	m
molecular weight	M
atomic weight	A
atomic number	Z
gram-equivalent weight	Z, J
Time	t
time interval, especially half- or mean-life	τ
frequency	ν
Velocity	v; c, (u, v, w)
of ions	u (with subscript)
angular	ω
Acceleration	$f \ldots a$
due to gravity (as variable)	g

Force	F, (X, Y, Z)
Moment of inertia	I
Pressure	p, P
especially osmotic	Π
Volume	v, V
Density	ρ . . . d
Compressibility	κ . . . K
Viscosity	η
Fluidity	ϕ
Surface area	A . . . s
Angle of contact	θ
Surface tension	γ . . . σ
Parachor	$[P]$
Surface concentration excess	Γ
Number of mols	n
Concentration, mol fraction	N, x
in other terms	c, C
Solubility	s
Diffusion coefficient	D
Chemical equilibrium constant (products/reactants)	K
solubility product	K_s . . . L
Velocity constant of chemical reaction	k
Number of molecular collisions per second	Z
Partition function	f
Efficiency, of any process	η
Wave function	ψ

Heat and Thermodynamics.

Temperature, on absolute scale, (°K)	T
on other scales	θ . . . t
Thermal conductivity	k
Energy (general symbol)	E
Work done by or on a system	w . . . W
Heat entering a system	q
Specific heat	c_p and c_v
molecular heat	C_p and C_v
Ratio of specific heats	γ
Latent heat, per g.	l
per mol	L
Intrinsic energy	U . . . E
Enthalpy, total heat, or heat content	H
Entropy	S
Free energy (Helmholtz)	A . . . F
Thermodynamic potential, Gibbs function, free energy (G. N. Lewis)	G

Vapour pressure constant	i
Chemical potential	μ
Activity	a
coefficient (for molar concentration)	f
Osmotic coefficient	g
Van 't Hoff's factor	i

Electricity.

Quantity of electricity	Q
especially electrostatic charge	e
Potential (difference)	V
Volta potential	V
electrokinetic potential	ζ
especially electromotive force of voltaic cells	E
Potential gradient, in electric field	X
Electronic exit work function	ϕ
Current	I
Resistance	R
specific resistance	ρ . . . r
specific conductance	κ . . . σ
Inductance, self	L
mutual	M
Electrostatic capacity	C
Dielectric constant	ϵ
Dipole moment	μ

Electrochemistry.

Degree of electrolytic dissociation	α
Valency of an ion	z
Ionic strength	I
Equivalent conductance	Λ
equivalent ionic conductance, "mobility"	l (with subscript)
Transport number	T (with subscript) . . . n (with subscript)
Single electrode potential	e (with subscript), E (with subscript)
Electrolytic polarisation, overvoltage	η . . . π

Magnetism.

Magnetic field strength	H
flux	ϕ
permeability	μ
susceptibility—volume	κ
mass	χ
moment	M
induction	B

Optics.

Wave length	λ
Wave number	ν
Intensity of light	I
Refractive index	n (with subscript) . . . μ (with subscript)
specific refraction	r (with subscript)
molecular refraction	$[R]$ (with subscript)
Molar extinction coefficient	ϵ
Angle of (optical) rotation	α
specific rotation	$[\alpha]$
Specific magnetic rotation	ω

3. To be Printed in Roman, when not Greek.

(a) *Examples of Mathematical Constants and Operators.*

Base of natural logarithms	e
Ratio of circumference to diameter	π
Differential	d
partial	∂
Increment	Δ
very small increment	δ
Sum	Σ
Product	Π
Function	f, ϕ

(b) *Examples of single-letter abbreviations.*

*Ampère (in sub-units)	a.
Volt	v.
Ohm	Ω.
Watt	w.
Farad	f.
Henry	h.
Centigrade	c.
Fahrenheit	f.
Kelvin	k.
Ångstrom unit	a.
micron	μ.
metre	m.
gram	g.
litre	l.
Röntgen unit	r.
†Normal (concentration)	n.
†Molar (concentration)	m.

* *E.g.* "ma." for "milliampère"; but "amp." is preferred for "ampère."
† Separated by a hyphen (and no full stop) from a chemical formula which follows it.

The following prefixes to abbreviations for the names of units should be used to indicate the specified multiples or sub-multiples of these units:

M	mega-	$10^6 \times$
k	kilo-	$10^3 \times$
d	deci-	$10^{-1} \times$
c	centi-	$10^{-2} \times$
m	milli-	$10^{-3} \times$
μ	micro-	$10^{-6} \times$

e.g., MΩ. denotes megohm; kw., kilowatt; and μg., microgram. The use of μμ. instead of mμ. to denote 10^{-7} cm., or of γ to denote microgram is deprecated.

4. Subscripts and other Modifying Signs.

(a) *Subscripts to symbols for quantities.*

I, II . . .	*especially with symbols for thermodynamic functions*, referring to different systems or different states of a system.
1, 2 . . .	
A, B . . .	referring to molecular species A, B, etc.
i	referring to a typical ionic species i.
u	referring to an undissociated molecule.
+, −	referring to a positive or negative ion, or to a positive or negative electrode.
p, *v*, *T*	indicating constant pressure, volume, and temperature respectively.
q	indicating adiabatic conditions.
w	indicating that no work is performed.
p, *c*, *a*	*with symbol for an equilibrium constant*, indicating that it is expressed in terms of pressure, concentration, or activity.
G, V, L, X	referring to gas, vapour, liquid, and crystalline states, respectively.
f, e, s, t, d	referring to fusion, evaporation (vaporisation of liquid), sublimation, transition, and dissolution or dilution respectively.
c	referring to the critical state or indicating a critical value.
0	referring to a standard state, or indicating limiting value at infinite dilution.
C, D, F	*with symbols for optical properties*, referring to a particular wavelength.

Where a subscript has to be added to a symbol which already carries a subscript, the two subscripts may be separated by a comma or the symbol with the first subscript may be enclosed in parentheses with the second subscript outside.

(b) *Other modifying signs.*

°	*as right-hand superscript to symbol*, referring to a standard state.
[ ]	*enclosing formula of chemical substance*, indicating its molar concentration.
{ }	*enclosing formula of chemical substance*, indicating its molar activity.

In crystallography it is recommended that :

Millerian indices be enclosed in parentheses, ( ) ;
Laue indices be unenclosed ;
Indices of a plane family be enclosed in braces, { } ;
Indices of a zone axis or line be enclosed in brackets, [ ].

Numerals attached to a symbol for a chemical element in various positions have the following meanings :

upper left	mass number of atom.
lower left	nuclear charge of atom.
lower right	number of atoms in molecule.

e.g., $^{7}_{3}Li$; $^{2}_{1}H_{2}$ (= D_2).

C. ALPHABETICAL INDEX OF RECOMMENDED SYMBOLS, and single-letter abbreviations.

including all those given in the above lists (Section B) except prefixes, subscripts and other modifying signs.

The name of any quantity for which a given symbol is a second preference is printed in parentheses.

A free energy—Helmholtz ; atomic weight ; surface area.
A. Ångstrom unit.
a activity ; (acceleration).
a. ampère, in sub-units—see footnote, p. 11.
B magnetic induction.
C concentration ; electrostatic capacity.
with subscript : molecular heat capacity.
c. Centigrade.
c velocity of light in vacuo.
c velocity ; concentration.
with subscript : specific heat.
D diffusion coefficient.
d diameter ; distance ; (density).
d differential.
∂ partial differential.
E energy ; (intrinsic energy) ; potential difference, especially electromotive force of voltaic cells.
with subscript : single electrode potential.
e electronic charge—charge equal and opposite in sign to that of an electron.
e quantity of electricity, especially electrostatic charge.
with subscript : single electrode potential.
e base of natural logarithms.
F Faraday's constant.
F force ; (free energy—Helmholtz).
F. farad ; Fahrenheit.
f acceleration ; activity coefficient, for molar concentration ; partition function.

f	function.
G	thermodynamic potential, Gibbs function, free energy—G. N. Lewis.
g	acceleration due to gravity, standard value.
g	acceleration due to gravity, as a variable; osmotic coefficient.
g.	gram.
H	enthalpy, total heat, heat content; magnetic field strength.
H.	henry.
h	Planck's constant.
h	height.
I	moment of inertia; ionic strength; electric current; intensity of light.
i	vapour pressure constant; van 't Hoff's factor.
J	mechanical equivalent of heat.
J	gram-equivalent weight.
K	chemical equilibrium constant; (compressibility).
	K_s, solubility product.
K.	Kelvin.
k	Boltzmann's constant.
k	thermal conductivity; velocity constant of chemical reaction.
L	latent heat per mol; self inductance; (solubility product).
l	latent heat per g.; length; mean free path of molecules.
	with subscript : equivalent ionic conductance, " mobility ".
l.	litre.
M	molecular weight; mutual inductance; magnetic moment.
M.	molar concentration.
m	rest mass of an electron.
m	mass.
m.	metre.
N	Avogadro's number.
N	mol fraction.
N.	normal concentration.
n	number of mols.
	with subscript : (transport number).
	with subscript : refractive index.
P	pressure.
[*P*]	parachor.
p	pressure.
Q	quantity of electricity.
q	heat entering a system.
R	gas constant per mol; Rydberg's constant.
R	electrical resistance.
[*R*]	*with subscript :* molecular refraction.
r	radius; (specific resistance).
	with subscript : specific refraction.
r.	Röntgen unit.
S	entropy.
s	solubility; (surface area).
T	temperature, on absolute Kelvin scale.
	with subscript : transport number.
t	time; (temperature—not on absolute scale).

U intrinsic energy.
u velocity component.
with subscript : velocity of ions.
V volume; potential, potential difference, including Volta potential.
v. volt.
v volume; velocity; velocity component.
W (work done by or on a system).
w. watt.
w work done by or on a system; velocity component.
X force component; potential gradient in electric field.
x mol fraction.
Y force component.
Z force component; g.-equivalent weight; number of molecular collisions per second; atomic number.
z valency of an ion.

α degree of electrolytic dissociation; angle of optical rotation.
$[\alpha]$ specific optical rotation.
Γ surface concentration excess.
γ ratio of specific heats; surface tension.
Δ increment.
δ very small increment.
ϵ dielectric constant; molar extinction coefficient.
ζ electrokinetic potential.
η efficiency of any process; viscosity; electrolytic polarisation, overvoltage.
θ angle of contact; temperature—not on absolute scale.
κ compressibility; specific conductance; magnetic susceptibility—volume.
Λ equivalent conductance.
λ wave length.
μ chemical potential; dipole moment; magnetic permeability.
with subscript : (refractive index).
μ. micron.
ν frequency; wave number.
Π pressure, especially osmotic pressure.
Π product.
π (electrolytic polarisation, overvoltage).
π ratio of circumference to diameter.
ρ density; specific resistance.
Σ sum.
σ diameter of molecules; (surface tension); (specific conductance).
τ time interval, especially half or mean life.
ϕ fluidity; electronic exit work function; magnetic flux.
Φ function.
χ magnetic susceptibility—mass.
ψ wave function.
Ω. ohm.
ω angular velocity; specific magnetic rotation.

Note.—The following distinctive letters have not been used in the above lists :

Italic capitals : *O*.
Lower case italic : *b*, *j*, *o*, *y*.
Greek capitals : Θ, Ξ, Υ, Φ, Ψ.
Lower case greek : β, ξ.

J. H. AWBERY.
F. G. DONNAN.
A. C. G. EGERTON.
H. J. T. ELLINGHAM.
A. FERGUSON.
G. I. FINCH.
C. F. GOODEVE.
J. R. PARTINGTON.
E. K. RIDEAL (*Chairman*).

9th June, 1937.

PRINTED IN GREAT BRITAIN BY RICHARD CLAY & SONS, LIMITED,
BUNGAY, SUFFOLK.